90-533

NO.

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM 1990

FREDERICK W. KANTOR, PETITIONER,

V.

UNITED STATES COURT OF APPEALS FOR THE

FEDERAL CIRCUIT, RESPONDENT

PETITION FOR WRIT OF CERTIORARI

TO THE U.S. COURT OF APPEALS FOR THE

FEDERAL CIRCUIT

PETITION FOR WRIT OF CERTIORARI

Dr. Frederick W. Kantor
pro se
Founder
Information Mechanics
523 West 112 Street
New York, NY 10025-1614
Telephone: 212 865 8492

QUESTIONS

1. How can the rights of an inventor under the first sentence of 37 CFR 1.104(a) be protected?
2. Is it true that the laws of thermodynamics do not brook contradiction?
3. Should dependence of an invention or application on Kantor's information mechanics for matter necessary for an enabling disclosure be grounds for denying issue of patent thereon?

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UNITED STATES COURT OF APPEALS FOR THE

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BEFORE THE BOARD OF PATENT APPEALS

AND INTERFERENCES ON APPEAL..... A3

Parties: Dr. Frederick W. Kantor, pro se; U.S. Patent and Trademark Office ("PTO"), under Commissioner of Patents, PTO attorney of record Fred E. McKelvey, with Teddy S. Gron, of PTO Solicitor's Office.

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STATEMENT OF RELATED OPINIONS

The decision by the Patent and Trademark Office ("PTO") Board of Appeals was appealed to the Court of Appeals for the Federal Circuit, whose judgment on this matter was filed June 1, 1990.

No other appeal from the Board of Patent Appeals and Interferences in connection with the patent application on appeal has been previously before this or

any other Court.

I do not know of any other related case pending in this or any other Court.

JURISDICTION

The date of entry of the judgment in the U.S. Court of Appeals for the Federal Circuit sought to be reviewed was June 1, 1990.

The date of the order respecting rehearing was July 2, 1990.

28 U.S.C. 1254(1) (as amended June 27, 1988, Pub.L. 100-352, 2(a),(b), 102 Stat. 662) is believed to confer on this Court jurisdiction to review the judgment in question by writ of certiorari.

CONSTITUTIONAL PROVISION:

U.S. Constitution Article I Section 8.
"The Congress shall have the Power***
***
To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors exclusive Right to their respective Writings and Discoveries;"

STATUTE:

The Racketeer Influenced and Corrupt Organizations Act (RICO), Pub. L. 91-452, Title IX, 84 Stat. 941, as amended, 18 U. S.C. SS961-1968 (1982 ed. and Supp. V). (see appendix page A36 bound herewith)

REGULATIONS:

37 CFR 1.75(d)(1) "The claim or claims must conform to the invention as set forth in the remainder of the specification and the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description."

37 CFR 1.104 "Nature of examination; examiner's action.
(a) On taking up an application for examination or a patent in a reexamination proceeding, the examiner shall make a thorough study thereof and shall make a thorough investigation of the available prior art relating to the subject matter of the claimed invention.***"

[I am not certain what this should be called]:
M.P.E.P. (Manual of Patent Examining Procedure) 608.01(p) (Rev. 8, Oct. 1981)
'B. Incorporation By Reference ***
"Essential material" is defined as that which is necessary to (1) support the claims, or (2) for adequate disclosure of the invention (35 U.S.C. 112). "Essential material" may not be incorporated by reference to *** nonpatent publications ***'

STATEMENT OF THE CASE

(a) The U.S. Court of Appeals for the Federal Circuit had jurisdiction under 35 U.S.C. 141 and 28 U.S.C. 1298(a)(4)(A).

(b) The Board of Patent Appeals and Interferences had jurisdiction below under U.S.C. 134.

(c) The decision of the Board of Patent Appeals and Interferences on request for reconsideration was entered on November 15, 1989. The time for appeal was two months. 35 U.S.C. 142 and 37 CFR 1.304(a). The notice of appeal was timely filed on December 14, 1989.

In 1972, through counsel, I filed a patent application for an invention based on new concepts in the foundations of physics pertaining to how information is represented in physical systems, including voluminous teaching of this new basis.

In 1977, John Wiley & Sons (New York,

London, Sidney, Toronto) published my research on this new basis as a monograph titled "Information Mechanics"; ISBN 0-471-02968-8; ca. xiii + 397 pages. This book is literally the defining work for the field, which is the fourth mechanics our civilization has had in more than 500 years. It has been through two printings (circa 2,500 copies sold). I streamlined and refiled my patent application, explicitly incorporating the book by reference. Receipt of a copy of the book by the Patent and Trademark Office ("PTO") was acknowledged in an "advisory action" dated Jan 28, 1980.

The PTO repeatedly placed this matter before an examiner who did not have the necessary training. The record shows that he did not know what boundary conditions were, and did not know which figures were which. In the course of this, we had a long meeting.

I appealed, and the PTO Board of Appeals ("the board") excluded my book from its deliberations, citing M.P.E.P. 608.01(p), and stated that my application was deficient and that my book was not properly incorporated by reference and was not even part of the record. (A16 bridging to A17) The board said that the competence of the examiner is irrelevant, citing In re Nilssen, 851 F.2d 1401, 7 USPQ2d 1500 (Fed. Cir. 1988). (A18) This is discussed further, below.

I petitioned the board for rehearing, noting the necessity of including the book in making a thorough study of my patent application. The PTO sent to me a new, hand-written paper by the examiner, directed against my book.

Having not received any paper from the board on my petition for rehearing, I again petitioned the board for rehearing, responding also to the examiner's new

paper.

The board maintained its original position excluding my book, introduced language against my person, and introduced two new arguments against my application, with permission for further rehearing denied. In its new arguments, 1. the board cited the U.S. Court of Appeals for the Federal Circuit ("CAFC") in Newman v. Quigg, as 886 F.2d 329, 11 USPQ2d 1340 (Fed. Cir. 1989), broadening the Court's statement into "the Court pointed out that there are certain laws of physics which do not brook contradiction".(A27) I traced the mis-citation back to the opinion in 877 F.2d 1575 (Fed. Cir. 1989), and saw that the Court had stated, "This court, like the master and the district court, believes that the laws of thermodynamics do not brook contradiction." (p.1580, left column, par.1, lines 6-8), according them

the standing of "inviolable scientific principles" (lines 13-14). That belief is in error.

2. the board cited a popular article by Abner Shimony, "The Reality of the Quantum World", Scientific American, pp. 46-53, Vol. 258, No. 1, 1988, asserting that it "validated" quantum mechanics as against information mechanics ("IM"). (A28) In fact, quantum mechanics itself fails via internal inconsistency, while a restricted basis for quantum mechanics free from that internal inconsistency appears as a derived result in IM; thus, evidence in support of quantum mechanics does not do so in contradistinction against information mechanics.

Because both new arguments were introduced with rehearing denied, and because the lowest court to correct an error of the CAFC is that Court in banc, I appealed to that Court. In my letter

suggesting hearing initially in banc, I furnished counter-examples to the three "laws" of thermodynamics.[1] In my informal brief, I expanded that discussion to include more examples and to explain how the change in reasoning plays an important role in understanding my invention.[2] Concerning the board's attempt to use Shimony's Scientific American article as if it were readable against my work, I showed, in my informal brief, that that line of reasoning was incorrect. As part of my discussion,[3] I applied IM to what, in quantum mechanics, had been one of the puzzling features Shimony referred to. (My IM analysis of that question was accepted 1990 Sep 04 for publication in the International Journal of Theoretical Physics, Georgia

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[1][2][3] A copy of this technical discussion has been provided to the Clerk.

Institute of Technology, Atlanta, Georgia 30332-0430.)

In defending the board's position, the PTO further broadened the Court's statement in Newman v. Quigg, supra, saying that the board "referred to a statement of this Court that recognized laws of physics do not brook contradiction"; this was discussed above and is discussed further, below.

The PTO cited In re Howarth, 654 F.2d 103, 107, 210 USPQ 689, 692-693 (Fed. Cir. 1981) as if against reliance on my book for essential material; this is discussed further, below.

The PTO also cited Standard Oil Co. v. American Cyanamid Co., 774 F.2d 448, 453, 227 USPQ 293, 298 (Fed. Cir. 1985), but, where the Court had stated, "And, the hypothetical person of ordinary skill in the art thinks along the line of conventional wisdom in the art and is not

one who undertakes to innovate", the PTO dropped the part "in the art***", and put a period after the word "wisdom". This made it appear to read against information mechanics. They used this falsely altered text in two places. This is discussed further, below.

In my reply paper, I addressed some of the matters having to do with logic and physics, but did not see how to fit a full discussion into the five-page limit. I had not yet fully recognized the nature of what the PTO had done.

In studying In re Howarth, I learned that the position taken by the board as to reliance on my book was directly contrary to the standards set by the Court. Meanwhile, the Court affirmed the PTO position. I petitioned for rehearing, spelling out this discrepancy, and suggested rehearing in banc to correct the error as to reliance on the "laws" of

thermodynamics.

The Court denied rehearing and declined my suggestion for rehearing in banc.

AUTHORITY WITH RESPECT TO QUESTION 2:

If Congress were to pass a law contrary to the laws of nature, then Congress would have erred. Similarly, a decision or remark by a Court or any other part of the U.S. Government contrary to the laws of nature is in error. The deepest formulation in our society for the laws of nature is the foundations of physics, the conceptual structure, or "mechanics", from which what are called laws of physics appear as derivable. In the sense that the laws of physics are statements about relations among events, they are opinion; but to reach such an opinion may take many years and many thousands of hours of intense thought.

In more than 500 years, our civilization has had four mechanics: Newton's mechanics, Einstein's relativistic mechanics, quantum mechanics, and Kantor's information mechanics. In three of those cases, respectively, the mechanics was set down by one man: Newton, Einstein, Kantor. I am Kantor.

Insofar as there is such a thing as authority in respect to the sciences, I have the authority which arises literally and directly from my authoring the fourth mechanics which our civilization has had in more than five hundred years. With respect to questions about the foundations of physics, my considered opinion constitutes an authority higher than that of the U.S. Government.

Question 2 falls within the scope of my work. In Newman v. Quigg, 877 F.2d 1575 (1989), the CAFC made in passing

affirmative statements as to what I have listed as question 2. In my considered opinion, the correct answer to that question is "no". I recognize that that Court plays an important role with respect to creative work. My appeal placed me in a position where I could, and did, furnish to that Court analysis and counter-examples for the Court to be able to use, within its rules and procedures, in correcting its error.

ON QUESTION 3:

Question 3 addresses whether people in this country will be able to obtain patents at home based on my mechanics. Patents play an important role in protecting this country's economy in contact with the world economy. In view of the conduct of the PTO discussed below, there seems little reason to expect the PTO to make an evaluation on the merits. The physics supports

answering "no" to question 3.

ON QUESTION 1:

Regarding question 1, something appears to be quite wrong with the internal activities in the PTO. The key to the proper functioning of the patent system is the scholarly scrutiny set forth in the first sentence of 37 CFR 1.104(a). And there is where the problem is:

> 37 CFR 1.104 "Nature of examination; examiner's action.
> (a) On taking up an application for examination or a patent in a reexamination proceeding, the examiner shall make a thorough study thereof and shall make a thorough investigation of the available prior art relating to the subject matter of the claimed invention.***"

The order in which the steps are performed is also important. From 37 CFR 1.75(d)(1), "*** the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the

terms in the claims may be ascertainable by reference to the description." Thus, it is improper to assume that one will be able to understand the claims without making a thorough study of the description and related antecedent basis. Only after one has made that thorough study can one properly ascertain what the claimed invention is, and only after reaching that state of knowledge is one in a proper position to search for available related prior art. The whole process depends crucially on good scholarship.

The scope of what needs to be included in that study depends on the scope of sources on which an applicant can properly depend for essential material for an enabling disclosure. This scope has been the subject of court decisions, and is determined thereby.

In In re Howarth, the Federal

Circuit Court's predecessor said,

> In In re Chilowsky, 43 CCPA 775, 780, 229 F.2d 457, 460, 108 USPQ 321, 324 (1956), this court stated:
>
> It is well settled that the disclosure of an application embraces not only what is expressly set forth in words or drawings, but what would be understood by persons skilled in the art. As was said in Webster Loom Co. v Higgins et al., 105 U.S. 580, 586, the applicant "may begin at the point where his invention begins, and describe what he has made that is new and what it replaces of the old. That which is common and well known is as if it were written out in the patent and delineated in the drawings."***

With respect to matters necessary for an enabling disclosure and which are not common or well known, an applicant may, in the interests of economy of time and space, incorporate certain types of documents by specific reference in his application to such source materials. After ruling that prior U.S. patents may be so incorporated, In re Stauber, 18 CCPA 774, 45 F.2d 661, 7 USPQ 258 (1930), this court extended the doctrine of incorporation by reference stating as a general guideline in In re Heritage, 37 CCPA 1109, 1115, 182 F.2d 639, 643, 86 USPQ 160, 164 (1950), that "any reference to a disclosure which is available to the public is permissible"***

To supplement a specification which on its face appears deficient under S112, evidence must establish that the information which must be read into the

specification to make it complete is known to those having ordinary skill in the art. We do recognize that part of the skills of such persons includes not only basic knowledge of the particular art to which the invention pertains but also the knowledge of where to search out information. Well known text books in English are obvious research materials***

When an applicant seeks to add necessary information to a specification by incorporating a source for the information by reference, public accessibility of that source alone may be the controlling factor.

The board excluded from its deliberations my defining monograph, Information Mechanics. I had referenced that book as the basis for my application and for the terms used, and provided explanation with many references and citations to help a reader. Because I am the person who created the field, and because that book is literally the defining work for the whole field, any person working in this art and reading a patent issued to me on this application would know where to look, even had I not

referenced the book. The book is available at libraries, including, by inter-library loan, ones which do not have a copy currently on the shelf. The record also includes a copy of a review in a popular magazine. The use of my book in the present situation appears to me to fully satisfy the conditions set down by the Court in In re Howarth.

To think about this work, one needs to be able to think quantitatively about amount and representation of information in physical systems; the only mechanics I am aware of which supports such thinking is the one I created.

That the board completely excluded that defining work, Information Mechanics, is shown by their statements, of which these are examples:

/1/"appellant never explains what information mechanics is" (A15, A25)

/2/"appellant's book has not been properly incorporated by reference in

this application (M.P.E.P. S608.01(p)), and in fact, is not even a part of this record." (A16 bridging to A17)

/3/"Moreover, it is incumbent on appellant to inform the artisan within the four corners of the patent application how to make and use the invention." (A17)

I looked at M.P.E.P. (Manual of Patent Examining Procedure) 608.01(p) (Rev. 8, Oct. 1981). Note the revision date. It said,

> B. Incorporation By Reference
> *** "Essential material" is defined as that which is necessary to (1) support the claims, or (2) for adequate disclosure of the invention (35 U.S.C. 112). "Essential material" may not be incorporated by reference to*** nonpatent publications ***,

contradicting, without referral, In re Heritage (1950).

Once the board had excluded Information Mechanics from its deliberations, it was a foregone conclusion that they not understand my work. They did not answer my subsequent questions about whether they had seen the

book. Even though what they wrote appeared to me to be irrational and demeaning, because of the above statement in M.P.E.P. and absence of reference to contrary court decisions, I did not recognize the true nature of their conduct.

Having read In re Howarth, I do not believe that the board's two opinions were in good faith nor done in line of duty. I do not believe that each and every one of the senior examiners on the board, Jerry D. Craig, Thomas E. Lynch, and James D. Thomas, was ignorant both of In re Howarth and of In re Heritage. I do not believe that these three senior examiners sitting as a tribunal would all be ignorant of the Court's standards for matters necessary for an enabling disclosure: they have the duty to act justly within our legal system; the phrase, "within our legal system",

includes among other things that they know what this Court, or the U.S. Court of Appeals for the Federal Circuit, or its predecessor, has decided on that critically important question.

In view of the foregoing, I regard the board's statement /3/ above as a direct lie; and I regard their statement /1/ above, and many consequent or other statements in their two opinions, as symptoms of the same disease. I regard the second part of their statement /2/ above as at best questionable; and they did not answer my subsequent questions about whether they had seen the book. I regard the first part of their statement /2/ above, together with the M.P.E.P. quotation, as an example of how the quasijudicial function of examiners and the function of the board as a tribunal can be systematically biased, whether by misleading a naive junior examiner guided

by that manual; or by providing a convenient means for a board to engage in deceit by citing an M.P.E.P. rule while disingenuously not citing contrary decisions by this Court, the Court of Appeals for the Federal Circuit, or its predecessor, of which they knew or should have known; or by misleading an applicant or counsel appearing before the examiner or the board. I regard it as deceit on the part of the PTO to have retained that M.P.E.P. rule without stating with it any decision to the contrary in the courts above the PTO. The PTO's not conforming its rule to the court decisions especially hurts an applicant who trusts that such a manual issued by the U.S. Government is in good faith. I say this from personal experience. The board lied, evaded its duties, and further abused its position of trust as a tribunal wantonly to make sport at my work and at my

person. Part of what is great and precious about this country is the concept of "with liberty and justice for all" in the pledge of allegiance. To me, it is far too precious to treat as these people have.

Note that to rely on In re Nilssen, supra, the board necessarily omitted the guiding principle behind the Court's decision, specifically, that the record in that case showed that the board had understood the claimed invention. In its use of Newman v. Quigg, supra, the PTO broadened the meaning twice, turning an error of fact into an error of philosophy against any fundamentally new basis for physics. In its use of In re Howarth, supra, the PTO omitted the main thrust of the Court's decision, and sought to have my explicitly cited book be excluded as if on the basis which the Court had used to exclude reliance on an uncited patent

issued in Rhodesia, Panama, and Luxembourg. In its use of Standard Oil Co. v. American Cyanamid Co., supra, the PTO falsely altered the meaning so as to make novelty a vice rather than a virtue. In each of these examples, the PTO selected or fabricated a meaning which departs from the guiding concept behind the Court's decision, in each case deviating in such way as to obstruct the evaluation of the merits of apparatus and method based on fundamentally new work.

The examiner, the board, and PTO counsel all endeavored to avoid having to think about fundamentally new material. It has been, and is, degrading to be required, under risk of forfeiting potential protection of my invention rights, to teach people who believe that they do not have the corresponding duty to learn, but are placed in a position supposedly to judge my work.

In these ways, detailed above, the conduct of the examiner, the board, and PTO counsel has been directly opposite to the constitutional basis for the existence of the Patent Office, which is "***To promote the Progress of Science and useful Arts***" (emphasis added).

In Pac-Tec, Inc. v. Amerace Corporation, 903 F.2d 796, 800 (Fed. Cir. 1990), the Court below said,

> "the conduct of counsel in this litigation infects the judicial process with a disabling disease of deceit that the courts must act to expunge, for if courts remain passive, that disease will spread until it destroys a judicial process and a legal profession no longer worth preserving."

In the PTO's conduct in this matter, that disease is not limited to counsel. I quoted that decision in petitioning the CAFC for rehearing and in suggesting rehearing in banc. The Court denied rehearing and declined to rehear in banc.

The examiners are supposed to be

working on my team. They are supposed to help me protect my reputation by catching error, and to help me avoid accidental harm to myself and others by finding any relevant prior art. Money is paid to the PTO to buy an important service of scholarly scrutiny. But, to be on my team, people must "make a thorough study"; not just when they are working on my material, but as a steady standard of scholarship so that when they look at work of mine, they will bring to it knowledge needed for scholarly scrutiny.

The nature of scholarly scrutiny is such that examiners cannot act with shabby scholarship on my work, and then provide good scholarship to others; nor can they provide good work for me, having done a shabby job for others. This problem is by its nature a system problem, affecting more than one person. Also, the existence of M.P.E.P.

608.01(p), in direct contradiction to the Court's standards, is evidence of a system problem.

This problem also affects interactions between people outside the PTO. When people negotiate a patent license, they need to be able to depend on the scholarship and good faith of the Patent Office. A large fraction of the business decisions and career decisions which people make are affected directly or indirectly by the patent system. In the long term, the economic and industrial well-being, and military strength, of this country depend on the proper functioning of the patent system: including the important properties of good scholarship, good faith, and promptness.

I recognize that performance of the duty to make a thorough study may require adding more examiners and increasing

their pay levels. But first, the standards for examination must be based on thoroughness and quality, not on how many pieces of paper are handled per unit time. Buying more of the same that the PTO does now would not solve the problem.

Further, I think that the conduct shown by the PTO in this case largely removes any reasonable expectation that this problem of failure to make a thorough study will be solved within the PTO itself. As I pointed out in my papers in proceedings below, once one has filed an application and publicly disclosed important material contained in it, one is in a situation where, to avoid abandoning one's rights, one is faced with repeated refiling of continuations, etc. Money is paid over and over to the PTO in good faith, supposedly to pay for the performance of duties set forth in 37 CFR 1.104(a). The PTO is engaged in an

extended pattern of conduct which contains essential elements of fraud and of extortion. Further, they are shielded from the outside control of the market place, both because they have a monopoly, and because the attorneys who practice before them are not in a position to hold them accountable. This is a system problem: the control loop is missing.

In view of the definition given by this Court in H.J. INC., et al., etc., Petitioners, v. NORTHWESTERN BELL TELEPHONE COMPANY et al., 109 S.Ct. 2893 (1989), for "pattern", I timely raised, in proceedings below this Court, the question of whether the conduct of the PTO may fall under the RICO act. For example, for every one of my four patent applications pending when I appealed to the CAFC, the records show a history of failure by the PTO to comply with 37 CFR 1.104(a), apparently substantially

independent of the fact that these four applications spanned a wide range of required mental effort, and of the fact that one of them appears to be sufficiently "sensitive" that license for foreign filing was denied. Thus, the continuity requirement appears satisfied in two ways: with respect to the present application and its predecessors, the records show a sequence of related acts by the PTO extending over a substantial period of time; from cross-comparison with my other then-pending applications, and from the existence of M.P.E.P. 608.01(p), this appears to be a regular way for the PTO to conduct its ongoing legitimate business. One of those four applications issued as my U.S. Patent No. 4,944,872, on July 31, 1990; the copies I received contain a cluster of references in column 68 to a missing Figure 24, despite counsel's preliminary amendment

to strike all references to that missing figure on first filing in 1982: it was filed, and by PTO internal procedures "refiled" as a continuation; the filing fee was paid twice; and it was never studied thoroughly by an examiner.

The conduct of the PTO has raised grave questions about the candor and quality of faith which a person experiences in dealing with a branch of the U.S. Government. These questions have been developed, but not answered, in proceedings in the Court below.

CONCLUSION

For science, technology, and the decision process of the courts, it is important to correct the error made by the U.S. Court of Appeals for the Federal Circuit as to the "laws" of thermodynamics. I have furnished this Court with a basis for doing so.

The problem of malfunctioning of the Patent Office presented here appears to me to be of such nature and of sufficient importance to bring to the attention of this Court for consideration as a vehicle for carrying out its duties; I hereby do so.

Dr. Frederick W. Kantor
pro se
Founder
Information Mechanics
523 West 112 Street
New York, NY 10025-1614
Telephone: 212 865 8492

A P P E N D I X

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Note: This judgment is not accompanied by an opinion prepared for publication in a printed volume because it does not add significantly to the body of law and is not of widespread legal interest. It is a public record. It is not citable as precedent. The decision will appear in tables published periodically.

United States Court of Appeals for the Federal Circuit

90-1160

IN RE FREDERICK W. KANTOR

Judgment

ON APPEAL from the UNITED STATES PATENT & TRADEMARK OFFICE Board of Patent

Appeals and Interferences

in CASE NO(S). 550,990

This CAUSE having been considered, it is

ORDERED and ADJUDGED:

Per Curiam (NIES Circuit Judge, MILLER, Senior Circuit Judge, and GEORGE,* Judge). AFFIRMED. See Fed. Cir. R. 36.

ENTERED BY ORDER OF THE COURT

<SIGNATURE df>

Francis X. Gindhart, Clerk

DATED M JUN -1 1990

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* Judge Lloyd D. George of the United States District Court for the District of Nevada, sitting by designation.

Art Unit 233 Paper No. 24

Appeal No. 88-0689 LS

ON BRIEF MAILED

MAY 31 1989

PAT. & T.M. OFFICE

BOARD OF PATENT APPEALS

AND INTERFERENCES

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS

AND INTERFERENCES

Ex parte Frederick W. Kantor

Application for Patent filed November 10, 1983, Serial No. 550,990, which is a Continuation of Serial No. 293,231, filed August 17, 1981, now abandoned, which is a Continuation of Serial No. 138,727, filed April 9, 1980, now abandoned, which is a Continuation of Serial No. 959,445,

filed November 13, 1978, now abandoned, which is a Continuation of Serial No. 816,819, filed July 18, 1977, now abandoned, which is a Continuation-in-part of Serial No. 580,351, filed May 23, 1975, now abandoned, which is a Continuation of Serial No. 249,537, filed May 2, 1972, now abandoned. Information Mechanical Methods And Apparatus.

Gregor N. Neff, for appellant.

Primary Examiner - Terrell W. Fears.

Before Craig, Lynch and Thomas, Examiners-in-Chief.

Lynch, Examiner-in-Chief.

This is an appeal from the final rejection of claims 4, 5, 7-11, and 15-38, all the claims remaining in the

application.[1]

The claimed subject matter relates to a new type of physics for which the appellant has coined the term "Information Mechanics." The substance of information mechanics is best illustrated by independent claim 16.

Claim 16 reads as follows:

16. An information mechanical apparatus for information storage and/or processing comprising:

at least one member providing an extended medium which, along a direction of propagation, is substantially homogeneous with respect to the propagation of waves therein, in which a wave therein, if undisturbed, persists and is focused and refocused at

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[1] In the final rejection, the examiner also made final a restriction requirement. The restriction requirement is not further mentioned, and has been presumably dropped by the examiner. No claims stand withdrawn.

substantially the same location as it travels on the member;

means for introducing waves into said extended medium;

and

means for detecting the presence of said waves in said extended medium.

There are no references applied by the examiner.

Claims 4, 5, 7-11, and 15-38 stand rejected as being unpatentable under 35 U.S.C. S112, second paragraph, as being indefinite on the grounds that the claims are unduly multiplied.

Claim(s) 4, 22, and 30-35 stand further rejected as being unpatentable under 35 U.S.C. S112, second paragraph, as being indefinite. The examiner maintains that claim 4 is drawn to an aggregation of parts which have not been disclosed as operating together. The examiner objects to claim 22 in that the

limitation "substantially non-dissipative" is indefinite and negative. With respect to claims 30-35, the examiner maintains that the limitation "appears to be substantially equidistant from every point in a region therein" is indefinite.

Claims 4, 5, 7-11 and 15-38 stand further rejected as being unpatentable under 35 U.S.C. S112, first paragraph, as being based on an inoperative and inadequate disclosure.

Finally, claims 30-35 stands (sic) rejected as being unpatentable under 35 U.S.C. S101 as being directed to non-statutory subject matter.

Rather than reiterate the arguments of appellant and the examiner, reference is made to the briefs and answer for the respective details thereof.[1a]

[1a] Petitioner's footnote: a set has been provided to the Clerk.

OPINION

The rejection of claims 4, 5, 7-11 and 15-38, under the second paragraph of 35 U.S.C. S112, is reversed. With regard to these rejections, we have carefully considered the complete record and find ourselves in agreement with the appellant.

The rejection of claims 30-35, as being directed to non-statutory subject matter under 35 U.S.C. S101, is affirmed. As will be noted in the discussion to follow, this rejection is basically the same as the rejection under the first paragraph of 35 U.S.C. S112. See, Raytheon Co., v. Roper Corp., 724 F.2d 951, 220 USPQ 592 (Fed. Cir. 1982).

Finally, the rejection of claims 4, 5, 7-11 and 15-38, under the first paragraph of 35 U.S.C. S112, is also affirmed. We have carefully considered the complete record and find ourselves in

agreement with the examiner.

Under In re Moore, 439 F.2d 1232, 169 USPQ 236 (CCPA), we treat the rejections under the second paragraph of S112 first. The rejection of all the claims as being indefinite because they are unduly multiplied, must be reversed. Provided appellant has paid his fees and otherwise complied with the statute, there is no basis in the law for the examiner to require a limitation on the number and scope of the claims. See, In re Wakefield, 422 F.2d 897, 164 USPQ 636 (CCPA 1970); Ex parte Sheldon, 172 USPQ 314 (Bd. App. 1971); and M.P.E.P. S706.03(l). Accordingly, the rejection on the grounds of undue multiplicity is reversed.

The further S112, second paragraph, rejections of claims 4, 22 and 30-35 as being indefinite are also reversed. With respect to claim 4, a claim is not

necessarily indefinite merely because an aggregation of elements which do not clearly cooperate are recited. See, In re Gustafson, 331 F.2d 905, 141 USPQ 585 (CCPA 1964); In re Worrest, 201 F.2d 930, 96 USPQ 381 (CCPA 1953). With respect to claim 22, we see nothing indefinite about the limitation "substantially non-dissipative." The examiner has apparently equated breadth with indefiniteness. With respect to claims 30 to 35, the examiner has apparently confused this rejection for one properly made under S112, first paragraph, or S101, as will be discussed below. Accordingly all the rejections made under S112, second paragraph, are reversed.

Turning now to the rejections under S112, first paragraph, and S101, as noted above, these rejections are basically the same. As held in Raytheon Co. v. Roper Corp., supra, when an incorrect or

questionable theory of operation is included in a claim, and since it is for the invention as claimed for which enablement must exist, a rejection under the first paragraph of S112 is proper. Similarly, when a claim requires a means for accomplishing an unobtainable result, the claim must be considered inoperative. Accordingly a rejection under either or both SS101 or 112, first paragraph, may be proper.

Appellant's claims are directed to an "information mechanical" apparatus and method for the interconversion of thermal, electrical, light and\or acoustic energy, and\or information storage or processing. Thus, all the claims are based on appellant's new physics theory of "information mechanics." Appellant's theory has astounding implications on conventional physics. For example, appellant's

specification (pages 9-12) maintains that conventional physics such as Newton's mechanics, Einstein's mechanics, Maxwell's electromagnetic theory, quantum mechanics(QM), (QED), thermodynamic entropy theory, black holes, and the big bang theory are erroneous and misleading. Appellant further indicates that by use of information mechanics, entropy is reversible (spec., pgs. 16-17), that antigravity is possible (spec., pgs. 20-21 & 24), and that time can be made to vary (spec., pgs. 35-36, bridging par.). Accordingly, we hold that the examiner had a reasonable basis for challenging the operability and thus the adequacy of appellant's disclosure.

We further note that abstract intellectual concepts, ideas, laws of nature, scientific truths, mathematical algorithms, etc. are not statutory subject matter within the meaning of S101

of the patent statute. Diamond v. Diehr, 450 U.S.175, 209 USPQ 1 (1981); Parker v. Flook, 437 U.S. 584 (1978); and Gottschalk v. Benson, 409 U.S. 63, 175 USPQ 673 (1972). Rather it is the concrete implementation of such concepts or theories consisting of "***any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof***" which forms the subject matter of patentable inventions.

Here appellant presents several different embodiments of the invention which allegedly implement his information mechanics theory. Several of the embodiments, viz., Figures 1-13, do not appear to perform any useful function, and certainly do not demonstrate the principles of information mechanics. In this regard, we note that the examiner has consistently challenged appellant as

to these embodiments. For example, with respect to Fig. 1, appellant states (Spec., Pgs. 24-25) that information flows as a mass of energy between blocks 5 and 6. How does this demonstrate the new physics of information mechanics? In Figure 2, a mass transfer indicated by arrow 4 is supposed to indicate a flow of information between blocks 12 and 13. How does this demonstrate the new physics of information mechanics? Similar comments can be made with respect to the embodiments of Figures 3-13. None of these embodiments demonstrate how the interconversion of different forms of energy or information, as recited by the claims at issue, takes place. Other embodiments, such as the solar energy embodiments and the light bulb embodiment

may have some use,[2] but appellant never explains how these devices embody information mechanics or how they incorporate the same theory of operation as the embodiments of Figures 1-13. In other words, appellant never explains what information mechanics is or how it relates to the various embodiments. Finally, appellant never explains how the conventional theories of physics, which he asserts are either wrong or misconstrued, have been superceded by his theory.

As pointed out by In re Fouche, 439 F.2d 1237, 169 USPQ 429 (CCPA 1971), when

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[2] We note in passing that there are several references of record which disclose functional structures which seem to compare with appellant's solar and light bulb embodiments. See, for example, Williams et al., U.S. Patent No. 2,859,369, Patented November 4, 1958. While no prior art rejections are before us, the prior art should be considered if prosecution is resumed before the examiner.

the doubts expressed by the examiner under S101 are reasonable, the burden is on the appellant to show that his allegations for his invention are true. Similarly, under S112, once the examiner presents a reasonable basis for challenging the adequacy of appellant's disclosure, appellant is put to his proofs that the disclosure would have been enabling to the skilled artisan. In re Scarbrough, 500 F.2d 560, 182 USPQ 298 (CCPA 1974).

Rather than addressing these issues, appellant simply makes vague references to various portions of his book (Kantor, "Information Mechanics," John Wiley and Sons, N.Y., N.Y., 1977). Such does not satisfy the deficiencies of this disclosure, since appellant's book has not been properly incorporated by reference in this application (M.P.E.P. S608.01(p)), and in fact, is not even a

part of this record. Moreover, it is incumbent on appellant to inform the artisan within the four corners of the patent application how to make and use the invention. This has not been done here, and accordingly, we agree with the examiner that this application is inadequately disclosed and/or directed to non-statutory subject matter.

Appellant further argues that the examiner refuses to understand the concept of boundary conditions, that the examiner is a person who is blatantly and persistently not prepared to understand the invention, and that appellant believes that the merits of the invention have not been reached during all the years of examination. Accordingly, appellant requests that this case be reassigned to a new examiner who is highly competent in physics, and that the new examiner be given the time to learn

the new physics of information mechanics and that the calender be reset to zero until the learning has been accomplished.

Under 35 U.S.C. 134, the jurisdiction of the board is limited to review of rejected claims. Whether the examiner is competent to handle the subject matter of the application, is a matter which is petitionable to the Commissioner under 37 CFR SS1.181-1.183. This matter can be pursued if and when prosecution is resumed before the examiner. Here the competence of the examiner is irrelevant. See In re Nilssen, 851 F.2d 1401, 7 USPQ2d 1500 (Fed. Cir. 1988). In any case, for the reasons stated above, we agree that the examiner had a reasonable basis for challenging this disclosure. It may be that "Information Mechanics" will supercede all previous physics theories, and achieve acclaim in the future. However, here it is simply our duty to

rule on the merits of the rejections before us. We hold that appellant's application does not adequately disclose to the artisan what information mechanics is, nor does it disclose how operative processes or apparatuses which utilize information mechanics are made and used. Accordingly, the rejection of all the claims based on this theory must be affirmed.

The rejections of all the claims under 35 U.S.C. S112, second paragraph are reversed. However, we have affirmed the rejections under 35 U.S.C. S112, first paragraph, and under S101. Accordingly, the decision of the examiner is affirmed.

The provisions of 37 CFR 1.136(a) do not apply to the times for taking any subsequent action in connection with this appeal.

AFFIRMED

<SIGNED>

Jerry D. Craig)

Examiner-in-Chief)

)

<SIGNED>) BOARD OF

Thomas E. Lynch) PATENT APPEALS

Examiner-in-Chief) AND

) INTERFERENCES

<SIGNED>)

James D. Thomas)

Examiner-in-Chief)

Gregory (sic) N. Neff

Curtis, Morris & Safford

530 Fifth Avenue

New York, NY 10036

Art Unit 233 Paper No. 30

Appeal No. 88-0689 LS

ON BRIEF MAILED

NOV 15 1989

BOARD OF PATENT APPEALS

& INTERFERENCES

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS

AND INTERFERENCES

Ex parte Frederick W. Kantor

Application for Patent filed November 10, 1983, Serial No. 550,990, which is a Continuation of Serial No. 293,231, filed August 17, 1981, now abandoned, which is a Continuation of Serial No. 138,727, filed April 9, 1980, now abandoned, which is a Continuation of Serial No. 959,445, filed November 13, 1978, now abandoned,

which is a Continuation of Serial No. 816,819, filed July 18, 1977, now abandoned, which is a Continuation-in-part of Serial No. 580,351, filed May 23, 1975, now abandoned, which is a Continuation of Serial No. 249,537, filed May 2, 1972, now abandoned. Information Mechanical Methods And Apparatus.

Frederick W. Kantor, pro se.

Primary Examiner - Terrell W. Fears.

Before Craig, Lynch and Thomas, Examiners-in-Chief.

Lynch, Examiner-in-Chief.

ON REQUEST FOR RECONSIDERATION

This is in response to two requests

for reconsideration[1] of the decision of May 31, 1989, wherein the rejections of claims 30-35 under 35 U.S.C. S101 and of claims 4, 5, 7-11 and 15-38 under the first paragraph of 35 U.S.C. S112, were affirmed. We have carefully considered the arguments advanced by appellant, but find nothing therein to indicate that the decision was in error.

In our decision, we made the

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[1] A first request was filed on June 30, 1989, and the file was mistakenly forwarded to the examining Group. Instead of promptly returning the file to the Board, the examiner issued a paper dated July 13, 1989, commenting on the request. The examiner's paper prompted a further request for reconsideration filed August 14, 1989, which caused the file to be again mistakenly returned to the examining Group. The file has only recently been returned to the Board for consideration. Any delay is regretted. We further note that appellant is only entitled to a single request for reconsideration. See 37 CFR 1.197(b), copy attached. While we will consider both papers is (sic) this instance, appellant is advised that no additional reply will be made to any further requests for reconsideration in this appeal.

following findings with regard to the merits of appellant's claimed invention:

1. Appellant's claims are directed to an "information mechanical" apparatus and method for the interconversion of thermal, electrical, light and/or acoustic energy, and/or information storage or processing. Thus, all the claims are based on appellant's new physics theory of "information mechanics." Appellant's theory has astounding implications on conventional physics. For example, appellant's specification (pages 9-12) maintains that conventional physics such as Newton's mechanics, Einstein's mechanics, Maxwell's electromagnetic theory, quantum mechanics(QM), (QED), thermodynamic entropy theory, black holes, and the big bang theory are erroneous and misleading. Appellant further indicates that by use of information mechanics, entropy is reversible (spec., pgs. 16-17), that antigravity is possible (spec., pgs. 20-21 & 24), and that time can be made to vary (spec., pgs. 35-36, bridging par.). Accordingly, we hold that the examiner had a reasonable basis for challenging the operability and thus the adequacy of appellant's disclosure. (Decision, pages 4-5, bridging par.).

2. Here appellant presents several different embodiments of the invention which allegedly implement his information mechanics theory. Several of the embodiments, viz., Figures 1-13, do not appear to perform any useful function, and certainly do not demonstrate the principles of information mechanics. In

this regard, we note that the examiner has consistently challenged appellant as to these embodiments. For example, with respect to Fig. 1, appellant states (Spec., Pgs. 24-25) that information flows as a mass of energy between blocks 5 and 6. How does this demonstrate the new physics of information mechanics? In Figure 2, a mass transfer indicated by arrow 4 is supposed to indicate a flow of information between blocks 12 and 13. How does this demonstrate the new physics of information mechanics? Similar comments can be made with respect to the embodiments of Figures 3-13. None of these embodiments demonstrate how the interconversion of different forms of energy or information, as recited by the claims at issue, takes place. Other embodiments, such as the solar energy embodiments and the light bulb embodiment may have some use,[2] but appellant never explains how these devices embody information mechanics or how they incorporate the same theory of operation as the embodiments of Figures 1-13. In other words, appellant never explains what information mechanics is or how it relates to the various embodiments. Finally, appellant never explains how the conventional theories of physics, which he asserts are either wrong or misconstrued, have been superceded by his theory. (f.n. omitted, Decision, pages 5-6, briding (sic) par.).

Rather than addressing these issues, appellant argues that "[r]emoving the twists of argument, and collapsing the board's position down to its logical

structure, it is objecting to the work because the work is fundamentally new; after others have publicly acclaimed appellant's work, then the USPTO would feel more comfortable about issuing patents based on it -- but not, of course, in a timely manner to the man who created the foundations of the whole field."

We do not agree with appellant's assessment of the situation. We realize that the appellant is upset because the prosecution of this application has not gone in accordance with his expectations. Nevertheless, the kernel of the rejection has been entirely valid throughout the prosecution especially in view of the findings quoted above. Therefore, if and when prosecution is resumed, appellant should address the issues raised in these findings, keeping in mind that the PTO does not issue patents on theories, but

on concrete implementation of theories. Furthermore, appellant should address issues such as his assertion that the conventional theories of physics are erroneous. In this regard, appellant should be guided by the recent decision in Newman v. Quigg, 886 F.2d 329, 11 USPQ2d 1340 (Fed. Cir. 1989), where the Court pointed out that there are certain laws of physics which do not brook contradiction. Thus, while the PTO is to keep an open mind to the possibility that the phenomena manifested can be explained by theories that do not violate inviolable scientific principles, an applicant must provide test data which verifies the results claimed whenever a questionable theory is presented. Therefore, when prosecution is resumed in this case, appellant must present concrete examples of workable systems, and test data (not just argument) which

verifies any questionable theory in the application.[2] Moreover, if appellant is planning to rely on his textbook, it should be positively incorporated into this disclosure. See MPEP S608.01p.

We realize that appellant feels that the PTO has grieved him in the prosecution of this application. This is regrettable, but it cannot cause us to overlook the merits of the application. When the merits of the application are considered, we hold that the above findings are dispositive of the issues in

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[2] For example, appellant states that his system and method are based on a new theory which holds that quantum mechanics is wrong. However, the current literature clearly indicates that while quantum mechanics has some bizarre aspects, recent experimentation has provided concrete data which has validated the theory anew. See, Shimony, "The reality of the Quantum World," SCIENTIFIC AMERICAN, vol. 258, no. 1, January 1988, pages 46-53, copy attached. Thus, appellant's assertion that quantum mechanics is in error must be rejected until appellant proves otherwise.

this appeal. Thus, we see no basis for overturning our decision. Accordingly, the request has been granted to the extent of reconsidering our decision, but is denied with respect to making any changes therein.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR 1.136(a). See the final rule notice, 54 F.R. 29548 (July 13, 1989), 1105 O.G. 5 (August 1, 1989).

DENIED

<SIGNED>
Jerry D. Craig)
Examiner-in-Chief)
)
<SIGNED>) BOARD OF
Thomas E. Lynch) PATENT APPEALS
Examiner-in-Chief) AND
) INTERFERENCES

<SIGNED>)

James D. Thomas)

Examiner-in-Chief)

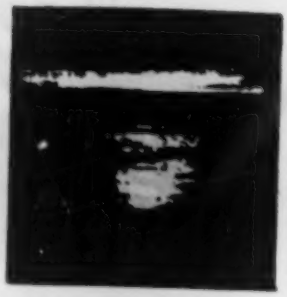
Frederick W. Kantor

523 West 112 Street

New York, NY 10025

SCIENTIFIC AMERICAN

January 1988 Volume 258 Number 1

30 

The Antarctic Ozone Hole
Richard S. Stolarski

A thin layer of ozone in the stratosphere protects human beings and other life forms by absorbing most of the ultraviolet radiation of the sun. The discovery of a springtime ozone "hole" over the South Pole suggests that the entire ozone layer may be thinning. What causes the hole—a global rise in pollutants or a natural change in Antarctic air movements?

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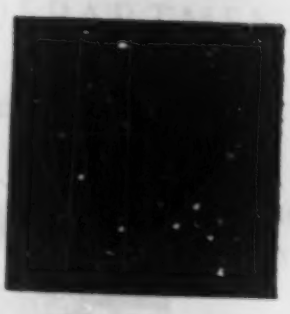
How Killer Cells Kill
John Ding-E Young and Zanvil A. Cohn

Killer lymphocytes, the commandos of the immune system, attack tumor cells and cells infected by viruses. They kill by secreting protein molecules that link to form pores in target cells; the cells promptly leak to death. Study of the process may make it possible to improve the killers' efficiency in fighting cancer and such viral infections as AIDS.

46 

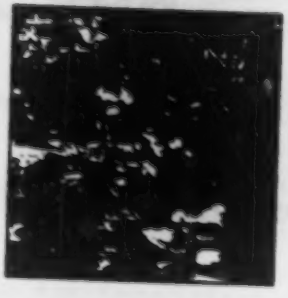
The Reality of the Quantum World
Abner Shimony

Is a photon a particle or a wave? That depends, the quantum mechanic says, on how—and when—you look at it. Common sense and aesthetics say it must be one or the other; the paradox bothers nonphysicists, and indeed it bothered Einstein. Yet the quantum mechanic is right. Elegant benchtop experiments show that the bizarre quantum world is real.

54 

The Very-Long-Baseline Array
Kenneth I. Kellermann and A. Richard Thompson

The resolution of a radio telescope depends on the diameter of its antenna. The VLBA, an array of 10 antennas stretching from the Virgin Islands to Hawaii, will have an effective "diameter" of some 8,000 kilometers. With it astronomers will study such deep questions as whether black holes are the source of the prodigious energy of quasars.

64 

Intertidal Fishes
Michael H. Horn and Robin N. Gibson

How can fish live in the harsh intertidal zone, where they are buffeted by waves and currents when the tide is in and are often left high and dry at low tide? Remarkable adaptations—including tolerance of dehydration, fins modified for crawling and clinging and even the ability to breathe air—make survival possible where the oceans and seas meet the land.

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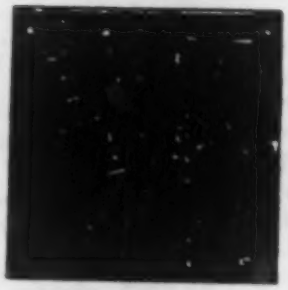
The Not-So-Rare Earths
Gunter K. Muecke and Peter Moller

They are neither rare nor earths. They are metallic elements present in small concentrations in most minerals. Their relative abundance gives geologists clues to the geochemistry of magmas and hydrothermal solutions. The rare earths are essential constituents of advanced alloys, laser crystals and the new high-temperature superconductors.

78 

Art, Illusion and the Visual System
Margaret S. Livingstone

The verve of op art, the serenity of a pointillist painting and the 3-D puzzlement of an Escher print derive from the interplay of the art with the anatomy of the visual system. Color, shape and movement are each processed separately by different structures in the eye and brain and then are combined to produce the experience we call perception.

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The Transformer
John W. Coltman

Invented in the mid-19th century, it is still essential: it makes electricity a convenient form of energy by converting a generator's low-voltage, high-current output into high-voltage, low-current power for efficient transmission—and then back again for consumption. Without it homes, office buildings and factories would need their own generators.

DEPARTMENTS

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50 and 100 Years Ago

1888: An Army engineer has made an electromagnet from a pair of 20-ton cannons.

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Atomic bearings, molecular computers and machines to ream out blood vessels.

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The Reality of the Quantum World

Einstein held that quantum-mechanical descriptions of physical systems are incomplete. Laboratory tests show he was probably wrong; the bizarre nature of the quantum world must be accepted

by Abner Shimony

We live in a remarkable era in which experimental results are beginning to elucidate philosophical questions. In no domain have the results been more dramatic than in quantum mechanics. The theory has been confirmed magnificently since the 1920's as its predictions of atomic, molecular, nuclear, optical, solid-state and elementary-particle phenomena were shown to be accurate. Yet in spite of these successes the bizarre and counterintuitive character of quantum mechanics has led some investigators, including Einstein, to believe quantum-mechanical descriptions of physical systems are incomplete and in need of supplementation. Recent experiments show that this opinion is very likely wrong. The experimental results reveal more clearly than ever that we live in a strange "quantum world" that defies comfortable, commonsense interpretation.

Here are a few of the new, strange findings we must begin to accept. First, two entities separated by many meters and possessing no mechanism for communicating with each other nonetheless can be "entangled": they can exhibit striking correlations in their behavior, so that a measurement done on one of the entities seems instantaneously to affect the result of a measurement on the other. The finding cannot be explained from a classical point of view, but it agrees completely with quantum mechanics. Second, a photon, the fundamental unit of light, can behave like either a particle or a wave, and it can exist in an ambiguous state until a measurement is made. If a particlelike property is measured, the photon behaves like a particle, and if a wavelike property is measured, the photon behaves like a wave. Whether the photon is wave- or particlelike is indefinite until the experimental arrangement is specified. Finally, the notion of indefiniteness is no longer confined to the atomic and subatomic domains. Investigators have found that a macroscopic system can under some circumstances exist in a state in which a macroscopic observable has an indefinite value. Each of these findings alters drastically the way we perceive the world.

An understanding of these experiments and their philosophical implications requires some familiarity with the basic ideas of quantum mechanics. Essential to any discussion of the theory is the concept of the quantum state, or wave function. The quantum state specifies all the quantities of a physical system to the extent that it is possible to do so. The caveat at the end of the preceding sentence is crucial, because according to quantum mechanics not all quantities of a system have simultaneously definite values. The familiar Heisenberg uncertainty principle, which asserts that the position and the momentum of a particle cannot be simultaneously definite, is perhaps the best-known instance of this proposition.

What the quantum state of a system does provide unequivocally is the probability of each possible outcome of every experiment that can be done on the system. If the probability is 1, the outcome is certain to occur; if the probability is zero, the outcome is certain not to occur. If, however, the probability is a number between zero and 1, then it cannot be said in any individual case what the outcome will be. All that can be said is what, on the average, the outcomes of a specified experiment carried out on a large number of replica systems will be.

Imagine, for instance, that measurements are made on a photon. The quantum state of the photon is fixed if three quantities are known: the photon's direction, its frequency and its linear polarization (the direction of the electric field associated with the photon). A suitable apparatus for measuring polarization is a sheet of polarizing film. The film is idealized so that it transmits all light incident on it at a right angle if the light is linearly polarized along a certain direction in the film called the transmission axis. The film blocks all light incident on it at a right angle if the light is linearly polarized perpendicular to the transmission axis.

Various experiments can be performed by rotating the polarizing film in different ways. If the photon is linearly polarized along the transmission axis, there is a probability of 1 that it will be transmitted. If the photon is linearly polarized perpendicular to the transmission axis, the probability that it will be transmitted is zero. A further implication of quantum mechanics, going beyond what has been said so far, is that if the photon is linearly polarized at some angle to the transmission axis between zero and 90 degrees, the probability of transmission is a number between zero and 1 (specifically, the square of the cosine of that particular angle). If the probability is, say, one-half, then out of 100 photons linearly polarized at the corresponding angle to the transmission axis 50 will be transmitted on the average.

Another basic idea of quantum mechanics is the superposition principle, which asserts that from any two quantum states of a system further states can be formed by superposing them. Physically the operation corresponds to forming a new state that "overlaps" each of the states from which it was formed. The concept can be illustrated by considering two quantum states of a photon in which

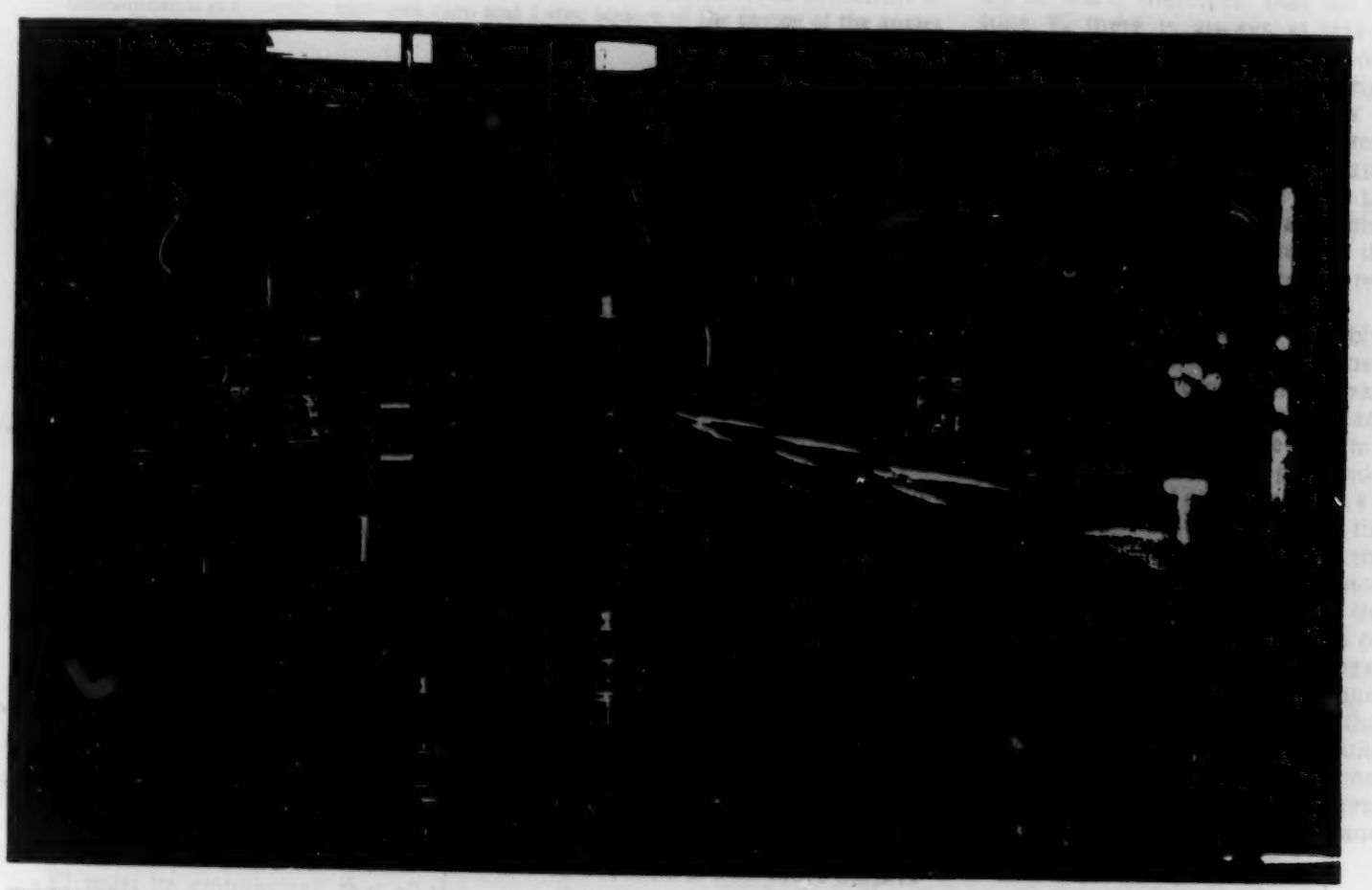
the direction of the photon's polarization in the first state is perpendicular to the direction of the photon's polarization in the second. Then any number of states can be formed in which the photon's polarization points at some angle between the two perpendicular directions.

From these two basic ideas alone—indefiniteness and the superposition principle—it should be clear already that quantum mechanics conflicts sharply with common sense. If the quantum state of a system is a complete description of the system, then a quantity that has an indefinite value in that quantum state is objectively indefinite: its value is not merely unknown by the scientist who seeks to describe the system. Furthermore, since the outcome of a measurement of an objectively indefinite quantity is not determined by the quantum state, and yet the quantum state is the complete bearer of information about the system, the outcome is strictly a matter of objective chance—not just a matter of chance in the sense of unpredictability by the scientist. Finally, the probability of each possible outcome of the measurement is an objective probability. Classical physics did not conflict with common sense in these fundamental ways.

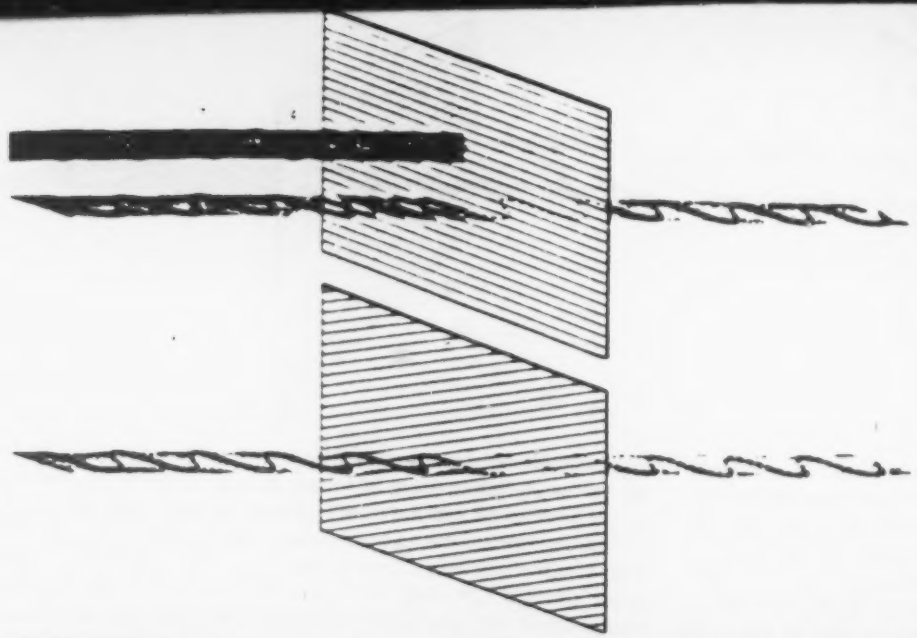
Even more startling implications flow from quantum mechanics if the system consists of two correlated parts. Suppose two photons fly apart in opposite directions. One possible quantum state of the pair of photons is the state in which both photons are linearly polarized along a vertical axis. Another possible state is the one in which they are both linearly polarized along a horizontal axis. There is nothing particularly bizarre or surprising about either of these two-photon quantum states, beyond the peculiarities of the single-photon states mentioned above. But if the superposition principle is brought into play, strange effects can occur.

In particular, by using the superposition principle one can form a qua. .m state that contains equal amounts of the vertically polarized state and the horizontally polarized state. This new state will figure prominently in what follows, and so it will be given a name. Ψ_0 (since the Greek letter psi is commonly used to represent a quantum state). The properties of Ψ_0 are most peculiar indeed. Imagine, for instance, inserting in the paths of the photons polarizing films with vertically oriented transmission axes. Because Ψ_0 contains equal amounts of the vertically and horizontally polarized states, there is a probability of one-half that both photons will be transmitted through their respective films and a probability of one-half that both will be blocked. What cannot happen is that one photon will be transmitted and the other will be blocked. In other words, the outcomes of the linear-polarization experiments on the two photons are strictly correlated.

The results will be the same if the polarizing films are oriented at an angle of 45 degrees with respect to



EXPERIMENTAL TESTS are now shedding light on topics in quantum mechanics that were once confined to the realm of philosophical debate. In this experiment, which was done by Alain Aspect and his colleagues at the Institute of Optics of the University of Paris, the lasers at each side of the picture excite individual calcium atoms in the vacuum chamber (*center*). Each atom returns to its unexcited state by emitting a pair of photons. (The photon is the fundamental unit of light.) The photons travel in opposite directions through 6.5 meters of pipe, and those that pass through polarization analyzers impinge on photodetectors. Quantum mechanics predicts there should be delicate correlations in the polarizations of the oppositely directed photons; the correlation conflicts with classical theories called hidden-variables models. The experiment confirmed quantum mechanics.



INDEFINITENESS of a quantum system is illustrated for a photon. A sheet of polarizing film transmits all light incident on it at a right angle if the light is linearly polarized along a certain direction in the film called the transmission axis (*hatching*). This polarization state of the photon is represented by the wavy colored line at the top. The film blocks all light incident on it at a right angle if the light is linearly polarized perpendicular to the transmission axis (*wavy gray line at top*). Now suppose a photon is linearly polarized at some angle to the transmission axis between zero and 90 degrees (*bottom*). Then whether or not the photon will be transmitted is indefinite: the probability of transmission is a number between zero and 1 (the square of the cosine of the angle).

the horizontal: either both photons will be transmitted or both will be blocked. It simply cannot happen that one photon will be transmitted and the other will be blocked. In fact, it does not matter what the orientations of the films are as long as they match each other: the outcomes of the linear-polarization experiments are strictly correlated for an infinite family of possible experiments. (Of course, no more than one of the experiments can actually be carried out.) Somehow the second photon of the pair "knows" whether to pass through its polarizing film in order to agree with the passage or nonpassage of the first photon, even though the two photons are well separated and neither has a mechanism for informing the other of its behavior. In this kind of situation, then, quantum mechanics challenges the relativistic concept of locality, which holds that an event cannot have effects that propagate faster than light (and, in particular, instantaneous effects at a distance).

It must be emphasized that all the peculiar implications that have been drawn so far—objective indefiniteness, objective chance, objective probability and nonlocality—depend crucially on the premise that a system's quantum state is a complete description of that system. A number of theorists have maintained, however, that the quantum state merely describes an ensemble of systems prepared in a uniform manner, and that this is why good predictions can be made about the statistical results of the same experiment performed on all members of the ensemble. At the same time, the argument goes, the individual members of the ensemble differ from one another in ways not mentioned by the quantum state, and this is the reason the outcomes of the individual experiments are different. The properties of individual systems that are not specified by the quantum state are known as hidden variables.

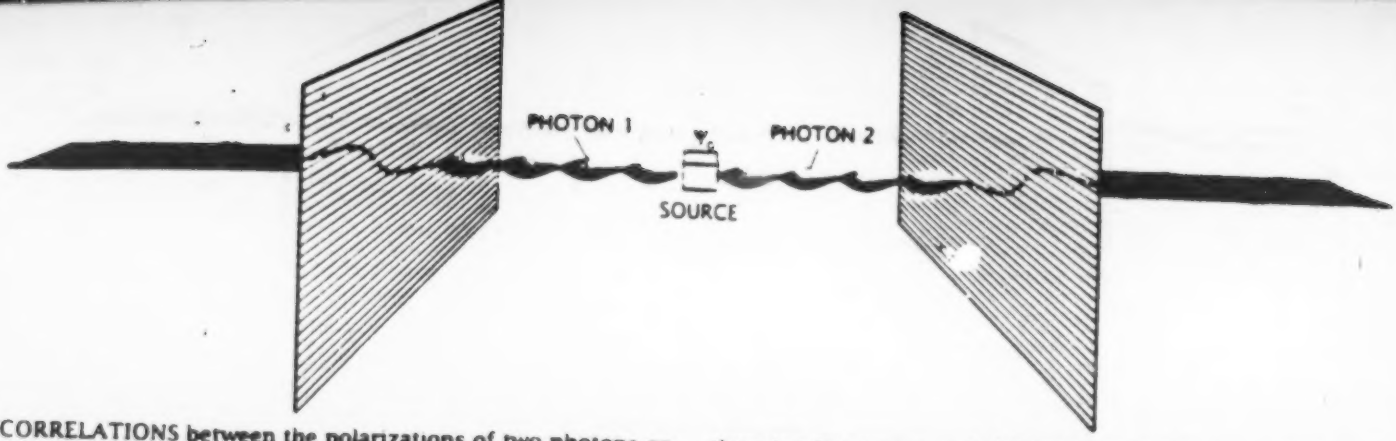
If hidden-variables theorists are correct, there is no objective indefiniteness. There is only ignorance on the part of the scientist about the values of the hidden variables that characterize an individual system of interest. Moreover, there is no objective chance and there are no objective probabilities. Most important, the quantum correlations of well-separated systems are no more surprising than the concordance of two newspapers printed by the same press and mailed to different cities.

In 1964 John S. Bell of CERN, the European laboratory for particle physics, showed that the predictions of local hidden-variables models are incompatible with the predictions of quantum mechanics. Reflection on some hidden-variables models of David Bohm of Birkbeck College London and Louis de Broglie led Bell to prove the important theorem that no model that is local (in a carefully specified sense) can agree with all the statistical predictions of quantum mechanics. In other words, there are physical situations in which the predictions of quantum mechanics disagree with those of every local hidden-variables model [see "The Quantum Theory and Reality," by Bernard d'Espagnat, SCIENTIFIC AMERICAN, November, 1979].

The idea of Bell's theorem can be grasped, at least in part, by returning to consider the quantum state Ψ_e. As noted above, the results of linear-polarization experiments performed on a pair of photons in this state must be strictly correlated when the angle between the transmission axes of the two polarizing films is zero degrees (as it is when both axes are aligned vertically). It should not be surprising to learn, therefore, that for the state Ψ_e there is always at least a partial correlation between the outcomes, no matter what the angle between the transmission axes is. (Specifically, if one of the photons is transmitted through its polarizing film, then the probability that the other photon will be transmitted through its film is the square of the cosine of the angle between the two transmission axes.)

Consequently a hidden-variables model that agrees with all the statistical predictions of quantum mechanics must assign quantities to each pair of photons in the ensemble in a delicate way in order to guarantee the strict or partial correlations at every angle between the axes. But the condition of locality requires that the quantities assigned to each photon in a pair must be independent of the orientation of the polarizing film on which the other photon impinges and independent of the other photon's passage or nonpassage. It is this locality condition that makes quite impossible the delicate adjustments that would be necessary for reproducing all the correlations, strict and partial, implied by Ψ_e.

Bell's theorem shows that in principle one can determine experimentally which is correct: quantum mechanics or the local hidden-variables models. It was important to do such a test because, in spite of the immense body of confirming evidence



CORRELATIONS between the polarizations of two photons occur when the photons are in a special state called Ψ_s (after the letter psi in the Greek alphabet). The state can be formed by superposing the state in which both photons are linearly polarized along a vertical axis with the state in which they are both linearly polarized along a horizontal axis. The state Ψ_s contains equal amounts of the vertically polarized state and the horizontally polarized state. Now imagine that polarizing films with horizontally oriented transmission axes are inserted in the paths of the photons. Since Ψ_s contains equal amounts of the two states, there is a 50 percent probability that both photons will be transmitted through their respective films and a 50 percent probability that both will be blocked. What cannot happen is that one photon will be transmitted and the other will be blocked: the outcomes of the linear-polarization experiments are strictly correlated. In fact, it does not matter what the orientations of the films are as long as they match each other: somehow the second photon of the pair "knows" whether to pass through its polarizing film in order to agree with the passage or nonpassage of the first photon, even though the photons are well separated.

for quantum mechanics at the time Bell proved his theorem, the very points where quantum mechanics is without equivocation irreconcilable with common sense had not yet been probed.

In 1969 John F. Clauser, then at Columbia University, Michael A. Horne of Boston University, Richard A. Holt, then at Harvard University, and I proposed a design for the requisite test. Pairs of photons with correlated linear polarizations were to be obtained by exciting atoms to an appropriate initial state; the atoms would subsequently return to the unexcited state by emitting two photons. Filters and lenses would ensure that when the photons flew off in opposite or virtually opposite directions, one photon would impinge on a polarization analyzer and the other would impinge on another analyzer. By switching between two orientations of each analyzer and recording the number of photon pairs transmitted in each of the four possible combinations of orientations of the two analyzers, measurements of correlations of transmissions of the photons of a pair could be made.

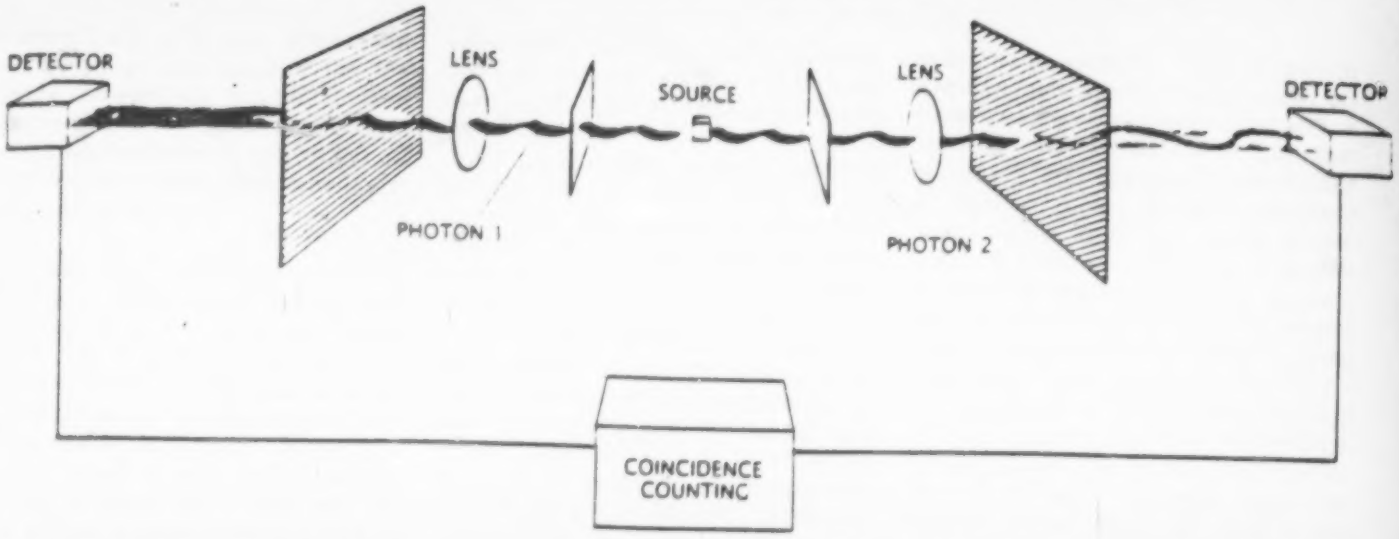
We suggested that either calcite crystals or piles of glass plates serve as the polarization analyzers, since each of them is much more efficient than an actual polarizing film in blocking photons polarized perpendicular to the transmission axis. Photodetectors placed behind the analyzers would detect a fixed fraction of the photons passing through the analyzers. If two photons, one at each detector, were registered within 20 nanoseconds (billionths of a second) of each other, the probability would be quite high that they were emitted by the same atom. Since the lenses would collect the two photons over a finite angle, the quantum state would not be exactly the Ψ_s state discussed above but a modified state Ψ_1, which also leads to correlations that cannot be reproduced by any local hidden-variables model.

The experiment was done by Stuart J. Freedman and Clauser at the University of California at Berkeley in 1972, by Edward S. Fry and Randall C. Thompson at Texas A. & M. University in 1975 and by other groups after that. Most of the experimental results agree with the correlation predictions of quantum mechanics and disagree with the hidden-variables models. Moreover, the reliability of the dissenting experiments is suspect because of subtle weaknesses in their design.

Yet until very recently all the experiments had a loophole that allowed staunch defenders of hidden-variables models to maintain their hopes: the polarization analyzers were kept in their respective orientations for intervals of a minute or so, which is ample time for the exchange of information between the analyzers by some hypothetical mechanism. As a result the defenders could contend that the special theory of relativity does not imply the validity of Bell's locality condition in the physical situation of the experiments. But then these experiments would not serve as decisive tests between quantum mechanics and the local hidden-variables models.

To block this loophole, Alain Aspect, Jean Dalibard and Gerard Roger of the Institute of Optics of the University of Paris did a spectacular experiment in which the choice between the orientations of the polarization analyzers is made by optical switches while the photons are in flight. In their experiment, which required eight years of work and was completed only in 1982, each switch is a small vial of water in which standing waves are periodically generated ultrasonically. The waves serve as diffraction gratings that can deflect an incident photon with high efficiency. If the standing waves are turned on, the photon will be deflected to an analyzer that is oriented one way; if the standing waves are turned off, the photon will travel straight to an analyzer that is oriented another way.

The switching between the orientations takes about 10 nanoseconds. The generators that power the two switches operate independently, although (unfortunately for the complete definitiveness of the experiment) the operation is periodic rather than random. The distance between the analyzers is 13 meters, so that a signal moving at the speed of light (the highest speed allowed by the special theory of relativity) takes 40 nanoseconds to travel between them. Consequently the choice of orientation for the first polarization



SEARCH FOR CORRELATIONS between members of pairs of photons was carried out in the 1970's by a number of investigators. The photon pairs were emitted in energy-state transitions of calcium and mercury atoms; each photon impinged on a polarization analyzer. Quantum mechanics predicts there must be delicate correlations in the passage or nonpassage of the photons through their analyzers, even though the photons have no apparent means of communicating with each other. The experiments mainly confirmed quantum mechanics, but they had a loophole: the orientations of the two analyzers were fixed before the photons were emitted. Consequently it was possible that information was somehow exchanged between the analyzers.

analyzer ought not to influence the transmission of the second photon through the second analyzer, and the choice of orientation for the second analyzer ought not to influence the transmission of the first photon through the first analyzer. The experimental arrangement is thus expected to satisfy Bell's locality condition. It follows that—according to Bell's theorem—there should be some violations of the quantum-mechanical predictions of correlations in the experimental outcome.

In point of fact, however, the experiment yielded just the opposite result. The correlation data agree within experimental error with the quantum-mechanical predictions that are calculated on the basis of the quantum state Ψ_1. Moreover, the data disagree by more than five standard deviations with the extreme limits allowed, according to Bell's theorem, by any of the local hidden-variables models.

Even though the experiment of Aspect and his colleagues is not completely definitive, most people believe the prospects of overthrowing the results by future experiments are extremely small. It seems unlikely that the family of local hidden-variables models can be salvaged. The strange properties of the quantum world—objective indefiniteness, objective chance, objective probability and nonlocality—would appear to be permanently entrenched in physical theory.

One of the strangest properties of the quantum world is nonlocality. Can the fact that under some circumstances a measurement on one photon apparently instantaneously affects the result of a measurement on another photon be capitalized on to send a message faster than the speed of light? Fortunately for the special theory of relativity the answer to the question is no. An underlying assumption of that theory—that no signal can travel faster than light—is preserved.

Here is a brief argument that shows why. Suppose two people want to communicate by means of a device similar to the one for testing local hidden-variables models. Between the observers a source emits pairs of correlated photons. Each observer is provided with a polarization analyzer and a photodetector. The observers are free to orient the transmission axes of their analyzers any way they choose.

Suppose the observers agree to align the transmission axes vertically. Then every time a pair of photons is emitted there will be a strict correlation in the outcome: either both photons will pass through the analyzers or both will be blocked. But the strict correlation is of no value for each observer in isolation from the other. The first observer will note that half of the time photons pass through the first analyzer, on the average, and half of the time they are blocked. The second observer will note the same thing for the second analyzer. In other words, each observer in isolation sees only a random pattern of transmissions and blockages.

Now imagine that the first observer tries to encode some information and send it to the second observer by changing the orientation of the first polarization analyzer. Depending on the orientation of that analyzer, there will be either a strict or a partial correlation between the outcomes of the events at each detector. Once again, however, each observer will note that on the average half of the time photons pass through the analyzer and half of the time they are blocked. In general, no matter what the orientations of the analyzers are, each observer in isolation sees only a random (and statistically identical) pattern of transmissions and blockages. The quantum correlations between the photons can be checked only by comparing the data accumulated at the two detectors. Hence the attempt to exploit the quantum correlations to send messages faster than light cannot succeed.

In this sense there is a peaceful coexistence between quantum mechanics and relativity theory, in spite of quantum-mechanical nonlocality. For this reason it would be misleading (and wrong) to say that nonlocality in the quantum-mechanical sense is a reversion to action at a distance, as in the prerelativistic gravitational theory of Newton. It is tempting to characterize quantum-mechanical nonlocality as "passion at a

distance," not with any pretension to provide an explanation for the strange correlations, but only to emphasize that the correlations cannot be exploited to exert a controlled influence more rapidly than a light signal can be sent.

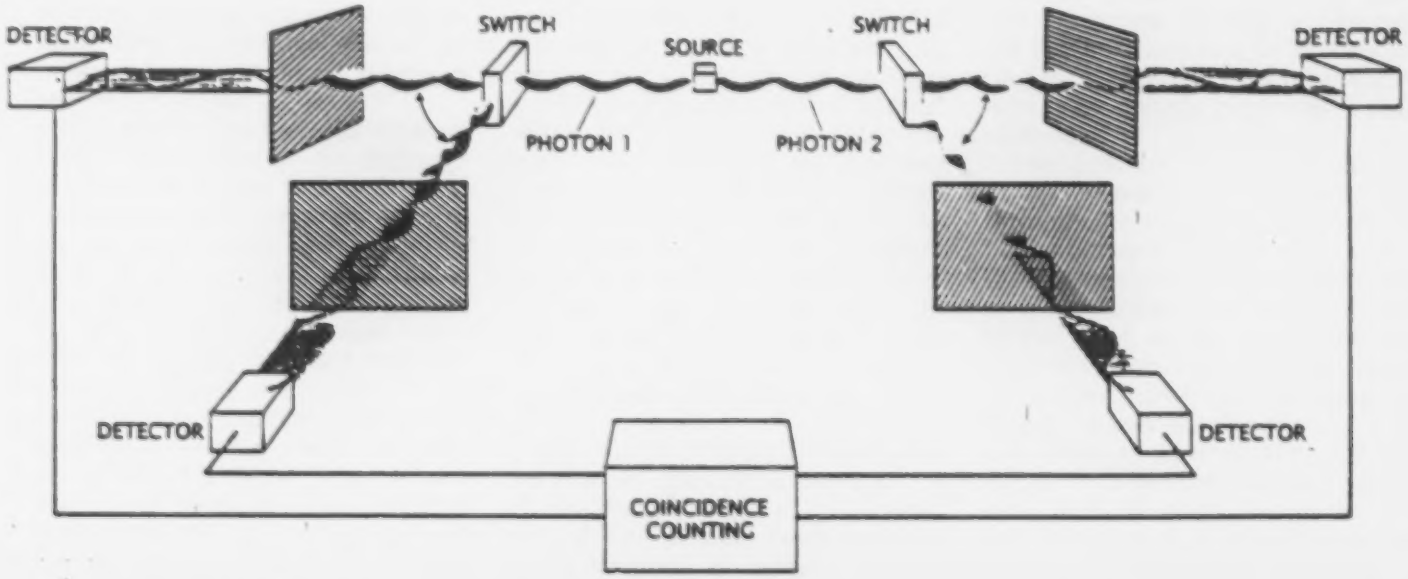
Another test, called the delayed-choice experiment, which was proposed in 1978 by John Archibald Wheeler, then at Princeton University, also reveals the strangeness of the quantum world. The basic apparatus of the experiment is an interferometer, in which a light beam can be split and recombined. A pulse of light from a laser is fired at the beam splitter, which is oriented in such a way that half of the light passes through the splitter and half is reflected at right angles to the direction of the incident pulse. If the light from the two paths is subsequently recombined, an interference pattern can be detected, which demonstrates the wavelike quality of light.

Now suppose the pulse of laser light is attenuated so severely that at any time there is only one photon in the interferometer. In this case two different questions can be asked about the photon. Does the photon take a definite route so that it is either transmitted or reflected by the beam splitter, thereby exhibiting a particlelike property? Or is the photon in some sense simultaneously transmitted and reflected so that it interferes with itself, thereby showing a wavelike property?

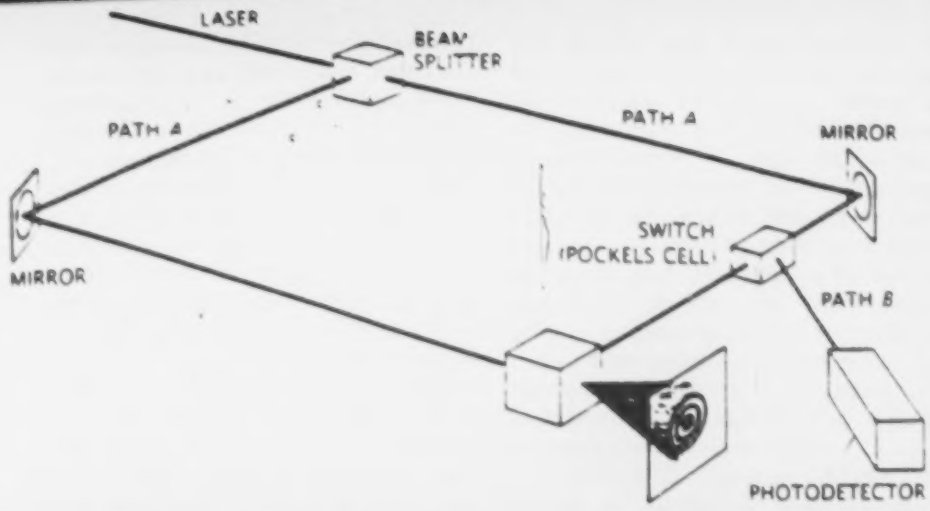
An answer was recently supplied by Carroll O. Alley, Oleg G. Jakubowicz and William C. Wickes of the University of Maryland at College Park and independently by T. Hellmuth, H. Walther and Arthur G. Zajonc of the University of Munich. Both groups found that a photon behaves like a particle when particlelike properties are measured and that it behaves like a wave when wavelike properties are measured. The remarkable novelty of the results is that the experiment was arranged so that the decision to measure particlelike or wavelike properties was made after each photon had interacted with the beam splitter. Consequently the photon could not have been "informed" at the crucial moment of interaction with the beam splitter whether to behave like a particle and take a definite route or to behave like a wave and propagate along two routes.

The length of both routes in the interferometer was about 4.3 meters, which a photon can traverse in roughly 14.5 nanoseconds. Obviously this does not allow enough time for an ordinary mechanical device to switch between measuring particle- and wavelike properties. The feat was made possible with a switch called a Pockels cell, which can be actuated in nine nanoseconds or less. A Pockels cell contains a crystal that becomes birefringent when a voltage is applied across it: light polarized along one axis of the crystal propagates at a velocity different from that of light polarized along the perpendicular direction. Given the proper choice of voltage and configurational geometry, light polarized in one direction when it enters the cell will emerge polarized in the perpendicular direction. The Pockels cell was inserted in one of the two routes the photon could take after interacting with the beam splitter [*see illustration on next page*].

A piece of polarizing film was the other essential element needed to switch between measurements of particlelike and wavelike properties. Light emerging from the Pockels cell impinged on the film. If the cell was "on," the polarization of the light was such that the polarizing film reflected the light into a photodetector, thereby answering the question of which route and confirming the photon's particlelike properties. If the cell was "off," the polarization of the light was such that the polarizing film transmitted the light, which then was combined with the contribution coming from the other route: interference ef-



RAPID SWITCHING between orientations of polarization analyzers as photons flew was the hallmark of the experiment done by Aspect and his colleagues (*see illustration on page 47*), which was completed in 1982. When a switch was "on," a photon was deflected to an analyzer that was oriented one way; when the switch was "off," the photon traveled straight to an analyzer that was oriented another way. The time required for light to travel between the analyzers was greater than the time required to switch between orientations, so that the choice of orientation for each analyzer could not influence the observation made at the other analyzer. (Unfortunately for complete definitiveness, however, the switching was periodic rather than random.) The experiment confirmed quantum mechanics; it would appear that the strange implications of the theory must be accepted.



DELAYED-CHOICE EXPERIMENT is another test that reveals the strangeness of the quantum world. A photon impinges on a beam splitter. Two questions about the photon can be asked. Does the photon take a definite route so that it is either transmitted or reflected by the beam splitter, thereby exhibiting a particlelike property? Or is the photon in some sense both transmitted and reflected so that it interferes with itself, exhibiting a wavelike property? To find out, a switch is positioned in one of the two paths the photon can take after interacting with the beam splitter (*here, path* A). If the switch is on, the light is deflected into a photodetector (*path* B), thereby answering the question of which route and confirming the photon's particlelike properties. If the switch is off, the photon is free to interfere with itself (*paths* A *and* A') and produce an interference pattern, demonstrating the photon's wavelike properties. Results from the experiment show that a photon behaves like a wave when wavelike properties are measured and behaves like a particle when particlelike properties are measured. Remarkably, the switch was triggered after the photon had interacted with the beam splitter, so that the photon could not have been "informed" whether to behave like a particle and take a definite route or to behave like a wave and propagate simultaneously along two routes.

fects confirmed the photon's wavelike aspect.

Both groups of investigators have reported results that are in excellent agreement with quantum mechanics. Their work shows that the choice between the two questions can be made after an individual photon has interacted with the beam splitter of an interferometer.

How are the results of the delayed-choice experiment to be interpreted? It is worthwhile first to disclaim one extravagant interpretation that has sometimes been advanced: that quantum mechanics allows a kind of "reaching into the past." Quantum mechanics does not cause something to happen that had not happened previously. Specifically, in the delayed-choice experiment quantum mechanics does not cause the photon to take a definite route at time zero if 12 nanoseconds later the Pockels-cell switch is turned on, and it does not cause the photon to take both routes, in wavelike fashion, if the switch is off.

A more natural interpretation is that the objective state of the photon in the interferometer leaves many properties indefinite. If the quantum state gives a complete account of the photon, then that conclusion is not surprising, since in every quantum state there are properties that are indefinite. But the conclusion does raise a further question: How and when does an indefinite property become definite? Wheeler's answer is that "no elementary quantum phenomenon is a phenomenon until it is a registered phenomenon." In other words, the transition from indefiniteness to definiteness is not complete until an "irreversible act of amplification" occurs, such as the blackening of a grain of photographic emulsion. Students of the foundations of quantum mechanics disagree about the adequacy of Wheeler's answer, however. The next experiment shows why the question is still open.

In 1935 Erwin Schrödinger proposed a famous thought experiment. A photon impinges on a half-silvered mirror. The photon has a probability of one-half of passing through the mirror and a probability of one-half of being reflected. If the photon passes through the mirror, it is detected, and the detection actuates a device that breaks a bottle of cyanide, which in turn kills a cat in a box. It cannot be determined whether the cat is dead or alive until the box is opened.

There would be nothing paradoxical in this state of affairs if the passage of the photon through the mirror were objectively definite but merely unknown prior to observation. The passage of the photon is, however, objectively indefinite. Hence the breaking of the bottle is objectively indefinite, and so is the aliveness of the cat. In other words, the cat is suspended between life and death until it is observed. The conclusion is paradoxical, but at least it concerns only the results of a thought experiment.

It is now more difficult to dismiss the paradoxical nature of the conclusion, because something similar to Schrödinger's thought experiment has recently been achieved by a number of groups of investigators including Richard F. Voss and Richard A. Webb of the IBM Thomas J. Watson Research Center in Yorktown Heights, Lawrence D. Jackel of the AT&T Bell Laboratories, Michael H. Devoret of Berkeley and Daniel B. Schwartz of the State University of New York at Stony Brook. Their work has relied to a certain extent on calculations that were done by Anthony J. Leggett of the University of Illinois at Urbana-Champaign and Sudip Chakravarty at Stony Brook, among other investigators.

The experimental apparatus consists of an almost closed superconducting ring. A thin slice of insulating material (called a Josephson junction) interrupts the ring, but an electric current can circulate around the ring by "tunneling" through the insulator. The current generates a magnetic field.

The quantity that is of interest in the system is the magnetic flux through the ring, which (when the field is uniform) is equal to the area of the ring multiplied by the component of the magnetic field perpendicular to the plane of the ring. If the ring were uninterrupted, the flux would be trapped within the ring, but the insulator allows the flux to slip from one value to another. With modern magnetometers the flux can be measured with fantastic accuracy. The fact that the flux arises from the motion of enormous numbers of electrons (on the order of 10^{23}) in the superconducting ring justifies speaking of the flux as a macroscopic quantity. There is now good evidence that states of the superconducting ring can be prepared in which the flux does not have a def-

finite value—a quantum-mechanical feature that had previously been established only for observables of microscopic systems.

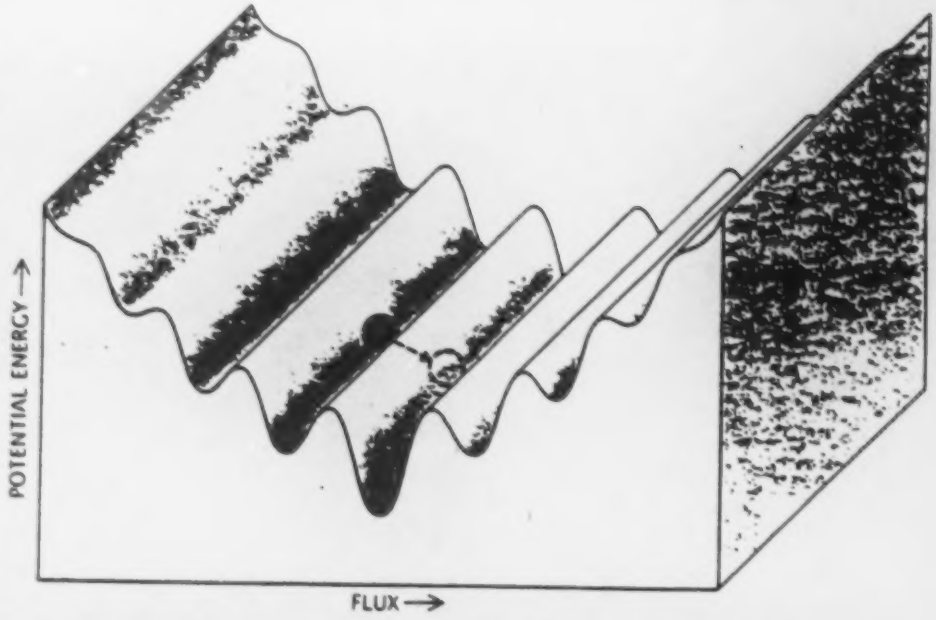
To understand how this indefiniteness is demonstrated experimentally, it is necessary to know that for each value of the flux the ring has a certain potential energy. Ordinarily one would not expect that the flux through the ring could change spontaneously from one value to another, because a potential-energy barrier separates adjacent values of the flux from each other. Classical physics forbids the transition between two such values of the flux unless some external source of energy, typically thermal, is supplied to traverse the barrier between them. In quantum mechanics, on the other hand, the barrier can be tunneled through without any external source of energy. The groups of investigators mentioned above have shown that the flux does change between two values, and that the change cannot be entirely accounted for thermally; the observed tunneling must be at least partially quantum mechanical, particularly at very low temperatures. But quantum-mechanical tunneling rests essentially on the indefiniteness of the flux, which thus cannot be localized definitely at or close to one value or another.

The experimental demonstration of quantum indefiniteness in a macroscopic variable does not ipso facto contradict the statement by Wheeler quoted above, but it does show that amplification from a microscopic to a macroscopic level does not in itself exorcise quantum-mechanical indefiniteness. The emphasis in Wheeler's statement about an "irreversible act of amplification" must be placed on the word "irreversible." The conditions for the occurrence of an irreversible process are far from settled in contemporary theoretical physics. Some students of the subject (including me) believe new physical principles must be discovered before we can understand the peculiar kind of irreversibility that occurs when an indefinite observable becomes definite in the course of a measurement.

The strangeness of the quantum world continues to be explored. Still other experiments have recently been performed or are now under way; two classes of these experiments should be mentioned here, even though there is no room to discuss them in detail. In the neutron-interferometer experiments of Helmut Rauch and Anton Zeilinger of the Atomic Institute of the Austrian Universities, Samuel A. Werner of the University of Missouri at Columbia and Clifford G. Shull of the Massachusetts Institute of Technology and their associates, the wave function of a neutron is split by a sheet of crystal and recombined by one or two other sheets. The interference effects exhibited in the recombination demonstrate a number of remarkable properties, including the indefiniteness of the neutron's route through the interferometer.

Finally, R. G. Chambers of the University of Bristol, G. Möllenstedt of the University of Tübingen and Akira Tonomura of Hitachi, Ltd., have confirmed by electron interferometry the remarkable Aharonov-Bohm effect, in which an electron "feels" the presence of a magnetic field that is in a region where there is zero probability of finding the electron. This is a striking demonstration of a kind of nonlocality different from, although remotely related to, the nonlocality exhibited by correlated photon pairs. A thorough understanding of the relation between the two kinds of nonlocality as well as the many other perplexing issues raised by experiments probing the nature of the quantum world awaits further work.

MACROSCOPIC SYSTEM can under some circumstances exist in a state in which a macroscopic variable has an indefinite value; indefiniteness is not limited to microscopic systems, such as the photon. The system shown here is a superconducting ring that does not quite bend back on itself. A thin slice of insulating material separates the two ends of the ring from each other, and an electric current is made to circulate around the ring by "tunneling" through the insulator. The current generates a magnetic field. If the ring were continuous, the magnetic flux through the ring (the area of the ring multiplied by the component of the magnetic field perpendicular to the plane of the ring) would be trapped at a fixed value, but the insulator allows the flux to slip from one value to another. Surprisingly, the flux does not have a definite value.



INDEFINITENESS in the system shown at the top of the page is depicted schematically. Each value of the flux through the superconducting ring has a certain potential energy associated with it. Ordinarily one would not expect that the flux through the ring could spontaneously change from one value to another, because a potential-energy barrier separates the adjacent values of the flux from each other. The barriers can be thought of as hills, and the state the system is in can be represented as a ball residing in a valley among the hills. According to classical physics, a transition between two values separated by a barrier requires outside energy (to push the ball over the hill). Quantum mechanically, however, the barrier can be tunneled through without any external source of energy. Tunneling is essentially a manifestation of the indefiniteness of the flux.

[attachment to PTO board's decision]

S 1.197 Action following decision

* * * * *

(b) A single request for reconsideration or modification of the decision may be made if filed within one month from the date of the original decision, unless the original decision is so modified by the decision on reconsideration as to become, in effect, a new decision, and the Board of Patent Appeals and Interferences so states. The request for reconsideration shall state with particularity the points believed to have been misapprehended or overlooked in rendering the decision and also state all other grounds upon which reconsideration is sought. See 37 CFR S 1.136(b) for extensions of time for seeking reconsideration.

United States Court of Appeals for the

Federal Circuit

90-1160

IN RE FREDERICK W. KANTOR

ORDER

[page]----------

O R D E R

Before NIES, Circuit Judge, MILLER, Senior Circuit Judge, and GEORGE,

A petition for rehearing having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for rehearing be, and the same hereby is, denied.

The suggestion for rehearing in banc is under consideration.

The mandate will issue on July 9, 1990.

FOR THE COURT,

Dated: July 2, 1990 <SIGNED>_____

Francis X. Gindhart

Clerk

cc: FREDERICK W. KANTOR

FRED E. MCKELVEY

FILED

U.S. COURT OF APPEALS FOR

THE FEDERAL CIRCUIT

JUL -2 1990

FRANCIS X. GINDHART

CLERK

IN RE KANTOR, 90-1160

(PTO - 550,990)

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*Note: This order has not been prepared *

*for publication in a reporter. *

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United States Court of Appeals for the

Federal Circuit

90-1160

IN RE FREDERICK W. KANTOR

ORDER

[page]----------

O R D E R

A suggestion for rehearing in banc having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the suggestion for rehearing in banc be, and the same hereby is, declined.

FOR THE COURT,

<SIGNED>

Francis X. Gindhart

Clerk

Dated: August 16, 1990

cc: FREDERICK W. KANTOR

FRED E. MCKELVEY

FILED

U.S. COURT OF APPEALS FOR

THE FEDERAL CIRCUIT

AUG 16 1990

FRANCIS X. GINDHART

CLERK

IN RE KANTOR, 90-1160

(PTO 550,990)

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*Note: This order has not been prepared *

*for publication in a reporter. *

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STATUTE:

The Racketeer Influenced and Corrupt Organizations Act (RICO), Pub. L. 91-452, Title IX, 84 Stat. 941, as amended, 18 U. S.C. SS 1961-1968 (1982 ed. and Supp. V).

Section 1961. Definitions
As used in this chapter--
(1) "racketeering activity" means (A) any act or threat involving *** bribery, extortion,*** which is chargeable under State law and punishable by imprisonment for more than one year; (B) any act which is indictable under any of the following provisions of title 18, United States Code: Section 201 (relating to bribery) *** sections 471, 472, and 473 (relating to counterfeiting),***section 1341 (relating to mail fraud), 1343 (relating to wire fraud),*** section 1503 (relating to obstruction of justice), section 1951 (relating to interference with commerce, robbery, or extortion), section 1952 (relating to racketeering)***;
***
(4) "enterprise" includes any individual, partnership, corporation, association, or other legal entity, and any union or group of individuals associated in fact although not a legal entity;
(5) "pattern of racketeering activity" requires at least two acts of racketeering activity, one of which occurred after the effective date of this chapter and the last of which occurred within ten years (excluding any period of imprisonment) after the commission of a prior act of racketeering activity;
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Section 1962. Prohibited activities

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(c) It shall be unlawful for any person employed by or associated with any enterprise engaged in, or the activities of which affect, interstate or foreign commerce, to conduct or participate, directly or indirectly, in the conduct of such enterprise's affairs through a pattern of racketeering activity or collection of unlawful debt.

(d) It shall be unlawful for any person to conspire to violate any of the provisions of subsection (a), (b), or (c) of this section.